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Introduction

This is a paper about knowledge in design and how to elicit knowledge from design processes. The paper is a preparation for an empirical study of interaction in the design process. Design is seen as an activity of creating forms and shapes, by addressing expert knowledge - in a dialogic way - to problematic situations. Due to my background as an architect, my experience is restricted to design of buildings, but the paper is dealing with design theory in general.

The first question is: What do we know about design? The answer is that we know rather little. Design theory is a new discipline and has faced the problem of a field dominated by *tacit thinking* and *knowledge*. Design is said to be an activity, where the processes are constituted and directed by *tacit knowledge*, and inaccessible by verbal description (Daley 1984, Molander 1993). There are some ideas about design knowledge, which have gained acceptance and hold a status of mature thinking. Much of the research - in the field of architecture - is concentrated on the ultimate objects of the design process. Historical descriptions of objects are the main issues. Still, the connections between the final object and the proceedings are few and hard to trace. In his introduction to research methods, in the chapter "The architect as designer", Broadbent states (1988, p. 1): "Buildings which look similar may have been designed in quite different ways. We may be misled if we try to deduce the architect's processes from his products".

The second question is: What is knowledge and how do we get access to it? In order to go deeper into this I shall discuss the view, which pragmatic philosophy has of knowledge, which at the same time is closely related to the elicitation of knowledge. I will examine the philosophy and the research methodology developed by Dewey. This approach, as a philosophy of *knowledge in action*, might offer an opportunity to understand more of the thinking inherent in design processes. The conclusion is that a study of design processes can look at three different forms of knowledge. Knowledge appears as a pre-cognitive understanding before the process of inquiry starts, as knowledge integrated in action, and thirdly, in the process of creating something new. According to Dewey it is possible to build up *objectified descriptions* of experiences, also of such, which are based on experiences of emotional and intuitive nature. The definite border, which separates tacit knowledge from explicit knowledge does not appear that way - when it comes to the possibility to make verbal descriptions. Tacit knowledge is possible to articulate within pragmatic thinking.

Design Theory

In order to give a picture about what can be regarded as the prevailing opinion of design theory I shall refer to reasonings of three authors; Schön, Broadbent and Lundequist. It is obvious that they have a pragmatic perspective in common, and that they regard the design process as an activity without a form, which could be clearly outlined.

Knowledge is here regarded as a diverse concept, which can represent different forms of knowledge. Not only as an experience, which can be observed, as described, but also as such, which can not be described verbally, so called tacit knowledge, as well as knowledge of second order, based on collection of earlier descriptions of experience. It is also obvious that it is difficult to separate knowledge as such from elicitation of knowledge. If it is only regarded as knowledge as such, a large part of the knowledge remains unnoticed. Lundequist, based on Molander, makes also a distinction between information and knowledge -

only humans possess knowledge, whereas all the other is called information (Lundequist 1995, p. 18).

Schön's texts about *reflection-in-action* are interesting in the discussion concerning design theory. He has developed a theory of practitioners acting in problematic situations; *reflection-in-action*. Some of the examples by which he describes the activities of practitioners concern the work of architects. He presents his theories in a form of an open reasoning. According to his ideas, practitioners build up a repertoire of examples, understandings and models of action from their experiences. This they reach by structuring the problems and through a dialogue with the situation. These experiences, Schön sees as models, which can be used as re-interpretation applicable on new occurring problematic situations, even if they are not identical. The task of the architect he sees as a reflective management of such situations using sketches, conceptual descriptions or other forms of models. Through a dialogue with the situation, and a modification of the models, the architect gathers new experiences and knowledge (1983, p. 140). It is a question of understanding the situations and managing them (chapter 6);

"When practitioners choose to address new or unique problems which do not fit known categories, their inquiry is [...] a design process artistic in nature and fundamentally similar in structure to the reflective conversations [...]. And when the science-based practitioners try to take account of the larger context of their inquiry, only some elements of which are within their control, they must construct a manageable problem from a problematic situation.

This repertoire represents the practitioner's experiences (ibid, p. 138); "A practitioner's repertoire includes the whole of his experience". He adds in a subordinate clause "insofar as it is accessible to him for understanding and action" in order to clarify that all experiences are not necessarily accessible. The practitioner uses this repertoire by seeing a situation as something that is known despite the fact that the new situation is not identical with the former (1983, p. 138f); "seeing *this* situation as *that* one, one may also *do* in this situation *as* in that one". Schön means that it is not possible to describe the knowledge of practitioners in any simple way, but that it indicates certain regularities, which are possible to describe, but which have been ignored within the knowledge theory of the "technical rationality" (1983, p. 172);

"...engineering design is understandable as a reflective conversation with the materials of a situation, a kind of process similar to the ones we have already observed in architecture and psychotherapy. Although it cannot be reduced to an application of general rules or theories, on the model of applied research, some of its main features are constant and amenable to description."

In his book "Design in Architecture" (1988) - which is a methodological presentation - Broadbent presents certain philosophical reasonings relating to design theory. His reasoning is based on Popper's concept "conjecture and refutation", and among other things he presents an *ethical program*. The designer has to filtrate - to test - design outlines against the items of the program. I present them in an extremely simplified form (p. 462);

- 1) the form has to suit the functions,
- 2) the material has to create a comfortable environment for people,
- 3) the symbolism has to be appropriate,
- 4) the costs have to be reasonable,
- 5) the effects on the environment have to be positive.

The program is actually only a formalization of the ethical rules of this field, which are not usually articulated. The way Broadbent sees design theory is influenced by Kuhn's (1970) paradigm theory. He is of the opinion that designers seem to be formed by a paradigm thinking. He then refers to different trends of architecture and says, that designers based on their paradigmatic thinking come to different results concerning the same task, despite the fact that they are principally occupying themselves with the same thing - analysis, synthesis and evaluation. For Broadbent there is no given method, which would be the best, but a diversity of ways of action (p. 460) - "batteries of techniques" - and one can use different ways of action in different stages, and this is applied on all different levels, on the whole as well as on small and large details of the task (p. 464). If the term "paradigm" is replaced by "context", it comes very close to

Schön's reasoning.

Lundequist sees design as an activity of gradual determination of the product to come. Solutions are sought in situations, where there still is a lack of information and knowledge. Based on Simon (1969) and Schön (1983) he sees design as an activity of managing problems with the help of models. The problems are of different quality - economical, technical, social - and ultimately it is a question of ethical evaluation. It is a process of negotiation, in order to define the appropriate qualities of the product. The word "negotiation"

must be seen in a broader sense. It consists of both the real negotiation with different parts of interests, and the dialogical reasoning performed by the designer in the sketching. In both cases the designer manages conflicts.

The Pragmatic Concept of Knowledge.

Based on the above mentioned theories I come to the conclusion that it can be motivated to study the *concept of knowledge* within pragmatism. I hope that the study also clarifies the concept of knowledge within design theory. Pragmatism includes a concept of knowledge, which differs from the positivistic view of knowledge, in which knowledge is something separate and objectivated. Pragmatics connect knowledge strongly with praxis and action. The clearest definition concerning knowledge is presented by the American philosopher John Dewey (1859-1952). He states that *action* is the source of knowledge. Knowledge can not be regarded as something separable; it must be viewed in context with elicitation of knowledge. We interact with the world, all the time, and this is the source of experiences, which can be elaborated into knowledge (Dewey 1938, 1939, p. 35);

"Experience occurs continuously, because the interaction of live creature and environing conditions is involved in the very process of living. Under conditions of resistance and conflict, aspects and elements of the self and the world that are implicated in this interaction qualify experience with emotions and ideas so that conscious intent emerges."

Dewey's idea is to focus on conditions and altering relations in real world situations, emphasizing the immediateness of experiences. The objects are the constituents of problematic situations but the changeable relations should be the object of experiment and reflective analysis (1910, 1951. p. 342); "the sole verifiable or fruitful object of knowledge is the particular set of changes that generate the object of study together with the consequences that then flow from it". Dewey regards logic, scientific methods and reason as *instruments* for knowledge elicitation. Theory can not be separated from practice, and research is a continuous process of doubt and action. Certain stages can be put forth as theoretical "steps" in order to enlighten this process, even if it from the philosophical view is inconsistent to separate these stages from the continuum. I present here a simplified description of Dewey's research methodology, which includes five stages:

1. The first stage is the confuse situation. Dewey (1939, 1939) talks about "problematic situations" (p.898) in order to describe the starting point, and that you go in for a "conscious search for problems" (p. 838) in order to locate the problem. So the initial situation is a situation where it is clarified and understood, what it is that needs to be solved (Dewey, 1930, 1951, p. 344);

"The risky character that pervades a situation as a whole is translated into an object of inquiry that locates what the trouble is, and hence facilitates projection of methods and means of dealing with it. Only after expertness has been gained in special fields of inquiry does the mind set out at once from problems; even then in novel cases, there is primarily a period of grouping through a situation which is characterized throughout by confusion."

2. The next step is the stage of ideas. For Dewey ideas represent ways of how to go on, how to proceed in the inquiry (1938, 1939, p. 890); "Some observed facts point to an idea that stands for a possible

solution". The ideas originate in earlier experiences and contexts. The emotional is prepared to react with the undefined, which you are encountered with in momentary situations of reality. The will-oriented in turn is connected with the emotional and has a tendency to react in order to get a grip of the undefined (1930, 1951, p. 347).

3. Changing the anticipated situations is the next step, on the path of inquiry. The situations must be analysed and understood, in order to be able to regulate them (1910, 1951, p. 894). Sensuous impressions are the starting point for the evaluation. The inquiry should be guided by reflection and thereby re-organize and test ideas in a fruitful way. It should be an inquiry open for new aspects and ideas (1930, 1951, p. 382).

Through *reflection* you can get a grip of the immediate experiences which you have had in interaction with the reality (1939, p. 934); "In reflection, the extrinsic reference is always primary". The understanding however has a connection with earlier experiences (ibid); "while reflective knowing is instrumental to gaining control in a troubled situation, it is also instrumental to the enrichment of the immediate significance of subsequent experiences". Without pre-understanding we can not arrange events into a context, so the events remain scattered.

4. An essential stage in assimilating experience is to organize it and communicate it. This is a step from the empiric experience, the experience based on senses, to intellectual knowledge, whereupon there is a shift from impressions dominated by feelings to conceptually structured knowledge (1940, p. 674). In order to make this possible we need language (1929, 1939, p. 804); "Without language, the qualities of organic action that are feelings are pains, pleasures, odors, colors, noises, tones, only potentially and proleptically. With language they are discriminated and identified". Through language the experienced impressions become objectified, as a quality resulting from interaction. The experiences get characterizing features, they become distinct, but they also have a general validity.

5. The intention is to establish and present causal relations representing real qualities and useful knowledge. This will help us understand other, similar relations through an associative transformation of thought. The process of change, reflection and *judgement* must be repeated until the distinctions and relations form "a copula of judgement expressing a transformation of the subject-matter of an indeterminated situation into a determinated one". A situation where the ambiguous and problematic has been resolved (1938, 1939, p. 909); "final judgement is attained through a series of partial judgements - those to which the name *estimates* or *appraisals* has been given". Still, this final judgement remains temporal in a longer term and there is no ultimate truth (1938, 1939, p. 889).

The method described concerns knowledge in action. In order to clarify certain features in Dewey's view of knowledge, I shall refer to Molander's presentation of the concepts of knowledge in action. My presentation of the concepts does not give credit to his, but the intention is to clarify certain features of Dewey. Molander's reasoning is an argumentation for the tacit knowledge and a strive to create a counteract to the traditional view of knowledge within science (1993, p. 47). The aim of the argumentation is to clarify the concepts relating to tacit knowledge and to reveal items that are not knowledge at all, either tacit or articulated. Molander reasons in similar paths as Dewey, but it seems that he does not consciously use Dewey's philosophy as his starting point.

Molander uses Habermas' concept "knowledge constituting interests" - consisting of a *technical*, a *practical* and an *emancipatorical interest of knowledge* - in order to try to grip some aspects of this type of knowledge. The word "interest" does not seem adequate, but the concepts are suitable to enlighten different sides of knowledge in action (1993, p. 174). Design theoretically it could be enlightening to divide the concept of knowledge into an *applying* and a *creative* aspect. The applying has a counterpart in the practical and technical interest of knowledge, whereas the creative aspect corresponds to the emancipatorical interest of knowledge. Design is about applying models - in both technical and social

contexts. Design is also characterized by the fact that it always concerns unique objects, where creation of something new is required. This requires a partly abandoning of former norms and thinking. Based on Polanyi, Molander suggests also a further division of tacit knowledge. This he does according to the basis of tacit knowledge. The basic factors he presents are: *physical body*, *culture* and *action*. Knowledge is a physical dimension, which is about both *knowledge* and *learning*, but the physical is a factor that research traditionally takes distance from. Culture is something grown into without critic, and through culture occurs a *communicative gathering of knowledge*. Action is the dynamic required by change, which learning is. There are also other factors, for example reflection and dialogue. These factors can not be defined, but are to be seen as loosely formulated *fields of tension* in a dynamic structure, where elicitation of knowledge occurs in a form of a *dialogical game*. Through objectivation the world becomes accessible for action, which also is a prerequisite for communicating the knowledge with others. This also contributes to development of new knowledge and getting a grip of it. Molander also suggests that the shifting between the pools of a field of tension is a prerequisite for learning - the shifting between action and reflection, or nearness and distance (1993, p. 278).

There is also another conceptual distinction of thinking and knowledge. In a paper discussing expert knowledge, and knowledge support systems, Kornell distinguishes between formal thinking and narrative thinking. Formal thinking is based on logical reasoning, whereas narrative thinking represents a non-algorithmic problem-solving (1988, p. 35);

"Two modes of thinking can be differentiated as the *formal* and the *narrative*. Formal thinking has to do with constructing publicly scrutable chains of reasoning, using explicit premises and methods of combination. The power of formal thinking is in allowing us to be as confident in the outcome of a chain of reasoning as we are in the premises. Narrative thinking has to do with implicit assumptions and plausible (or habitual) methods of combination. The power of narrative thinking is in allowing us to act reasonably in the real world."

These modes of thinking have different character and are applied on different situations. Kornell argues that support systems ought to have the same narrative patterns of reasoning, as those used by the experts in their problem solving. The concept "narrative" is described also by Bruner (1986). It represents something that exists in the ability of human thinking to abstract, and by doing so, to reach a high level of problem solving (p. 13);

"The imaginative application of the narrative mode leads to good stories, gripping drama, believable (though not necessarily "true") historical accounts. It deals in human or human-like intention and action and the vicissitudes and consequences that mark their course. It strives to put its timeless miracles into the particulars of experience, and to locate the experience in time and place."

Besides the concept of knowledge as such, the methodology of Dewey can offer a possibility to study the so called tacit knowledges within design in order to generate theories about design processes. It is a methodology, which moves in the outskirts of established research methodology, but there are intercessors, who claim that we must go beyond the rigorous rules of argumentation and recording to be able to develop new and promising theories. Applied on the research of design processes I see two alternatives concerning this. One is to study experimental situations from the outside, the other is to follow and change the reflections of a real design process by using participating observation. This opens several interesting alternative approaches and in addition to theory building qualitative features of design work can be revealed.

Conclusions.

I come to the conclusion that it is possible to study the non-verbal knowledge of design processes. It is

possible to study both different forms and qualitative features of the knowledge used in the elaboration of design, and creation of new knowledge. The results may not possess the rigorous character of objectivity, which is strived within the positivistic tradition, but in spite of that it could be of importance for the theory building within design theory.

In an extreme form it can be claimed that knowledge means applying known models on new problems. This is what Schön calls "seeing as something". In that case it is a question of knowledge in action, whereas creation of new knowledge remains marginal. It would also be interesting to study what kind of models designers use. Are they for example concept, function or outline oriented, and what role has information got within design? How is the external information integrated into the non-verbal processing of knowledge, which design work consists of? Design work includes a large quantity of revising of information, where the information is given as directives for planning, descriptions of products and designs - a mixture of verbal and visual information. My experience is that information is gathered in an informal way and that interaction has an important function (Östman, 1996). One explanation could be that interaction occurs in a narrative form, which is close to the way in which we apply knowledge in design processes. Seen in a broader perspective and regarding design based on data processing arouses the question: How can we go further from the design tools of today and come closer to the actual design work? One obvious answer is that we could use interaction based on visualization and case-based reasoning.

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